CHEM1902/4 Worksheet 4 – Answers to Critical Thinking Questions

The worksheets are available in the tutorials and form an integral part of the learning outcomes and experience for this unit.

Module 6: Polar Reactions

1. See below.

2. The negatively charged N atom will attack the \(\delta^+\) carbonyl C atom. A new N-C bond will form.

3. A bond would need to break. The \(\pi\) bond in the C=O group is the weakest and would break.

4. See below.

5. See above.

6. See below.

7. A stepwise reaction would involve the processes represented by the 3 arrows occurring separately. If either of the first two arrows are drawn on their own, a pentavalent carbon is formed. The third arrow would generate a positively charged secondary carbon.

   A concerted reaction avoids these issues. It is more likely as the new bonds are made at the same time as bonds are broken, minimizing the activation energy required.

Extension

\[ \Theta + \text{Br}^+ \] Leads to a positive charge on the more electronegative element.

\[ \Theta \text{Br}^+ \] Leads to a 5-valent carbon atom.

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Module 7: Electrophilic Additions

1. Nucleophile
2. Broken = red. Formed = blue.

Module 7: Electrophilic Additions

3. See above.
4. See below. The major product is 2-bromopropane.

5. The catalyst speeds up the reaction by lowering the energy required for the reactions.
   In the acid catalysed reaction, H₂O is not sufficiently electrophilic to initiate the reaction. H⁺ is a much better electrophile.
   In the hydrogenation reaction, H₂ adsors on the Pd surface and the H-H bond breaks. This activates the electrophile.

Extension

The aldol condensation is a nucleophilic addition reaction whereas addition to alkenes is an electrophilic addition.

6. FeCl₃ is a catalyst. It forms a highly electrophilic complex, transforming the non-polar Cl₂ molecule into a good electrophile.

7. See below. The resonance stabilises the intermediate.
Module 8: Nucleophilic Substitution

1. See below.

2. S = substitution, N = nucleophilic, “1” = unimolecular (key or rate determining step involves 1 molecule) and “2” = bimolecular (key or rate determining step involves 2 species).

3. The first reaction is likely to occur via $S_N2$. The carbon atom at which the nucleophilic attack occurs in this pathway is not very crowded. The $S_N1$ pathway would lead to a positive charge on a primary carbon atom, which is highly unstable.

The second reaction is likely to occur via $S_N1$. This pathway leads to a positive charge on a tertiary carbon which is stabilised by hyperconjugation. The $S_N2$ pathway would involve attack on a crowded carbon atom.

Key to success: practice further by completing this week's tutorial homework
Key to even greater success: practice even further by completing this week's suggested exam questions